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# TRANSACTIONS

OF THE

# KANSAS

# ACADEMY OF SCIENCE.

1874.

TOPEKA, KANSAS.
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1875.

# REPORT OF THE KANSAS ACADEMY OF SCIENCE.

The Kansas Academy of Science was made a co-ordinate branch of the State Board of Agriculture by the laws of 1873.

Nearly all of the members of the Society have contributed something in the interests of science.

Prof. B. F. Mudge, who has been collecting for Prof. Marsh, of Yale, has found many new and rare specimens, which have not yet been determined.

Prof. J. H. Carruth has added to his catalogue plants. He has been greatly assisted by Lieut. Wilcox of Fort Leavenworth, Miss Wright of Irving, Mr. Watson of Ellis, Mr. Popenoe, and others, who have contributed many new and important specimens.

Prof. Frank H. Snow, of the State University, has continued his observations on the "Birds of Kansas;" and Mr. E. A. Popenoe presents for the first time a list of the Coleoptera of Kansas.

## PROCEEDINGS OF THE SOCIETY.

The seventh annual meeting of the Society was held in the House of Representatives, at Topeka, on October 5th and 6th. The attendance was larger, and the interest greater than at any previous meeting.

Among the transactions of the Society the following are of public interest:

A committee, consisting of A. Gray, B. F. Mudge, and E. A. Popenoe, were appointed "to secure such a modification of the game laws of Kansas, as shall allow the killing of any birds at any time by authorized parties for scientific purposes."

Prof. Frank H. Snow was appointed to make a report on the ravages and extent of the locust, its means of extermination, together with any other information which may be considered of value to the citizens of the State.

The following papers were read:

Brachiospongia, by Prof. W. C. Hovey.

Tin and Tin Salts, by Prof. W. K. Kedzie.

Elementary Sounds of the English Language, by Prof. J. H. Carruth.

On the Priestly Centennial, by Prof. W. K. Kedzie.

Catalogue of the Lepidoptera of Kansas (continued from last year), by Prof. Frank H. Snow.

The Pliocene Formation of Kansas, by Prof. B. F. Mudge.

Artificial Organic Compounds, by Miss Jennie M. Detmers.

The Water Supply of Kansas, by W. Tweeddale.

Additions to the Catalogue of Kansas Birds, with remarks on the fertility of the Hybrid Woodpecker (*Colaptes hybridus*), by Prof. Frank H. Snow.

New and Rare Forms of Fossil Fish from Kansas, by Prof. B. F. Mudge.

Analysis of Clays from different parts of Kansas, by Dr. Wm. H. Saunders.

Additions to the Catalogue of Kansas Plants (continued from last year), by Prof. J. H. Carruth.

Notes from the Zoological Laboratory of the University of Kansas, by Prof. F. H. Snow.

A Mad Stone in Kansas City, by Prof. John D. Parker.

A Preliminary List of the Coleoptera of Kansas, by Edwin A. Popenoe.

Observations on the use of the Antennæ of *Polyphylla variolosa* (Harris), by Prof. F. H. Snow.

The Study of Natural History as a Disciplinary Power, by Prof. W. Wheeler.

The Importance of a Geological Survey of Kansas, by Prof. B. F. Mudge.

Geological Features of the Lower Neosho Valley in Kansas, by W. S. Newlon.

On Determining the Solubilities of Metallic Salts, by Prof. G. E. Patrick.

Disappearance of the Prairie Dog from Kansas, by Prof. B. F. Mudge.

Suggestions on the True Theory of Number, by Prof. F. W. Bardwell.

OFFICERS.

The following officers were elected for the current year:

*President*—Frank H. Snow, Lawrence.

*Vice Presidents*—B. F. Mudge, Manhattan; John D. Parker, Wyandotte.

*Secretary*—John Wherrell, Leavenworth.

*Treasurer*—Robert J. Brown, Leavenworth.

*Curators*—Frank H. Snow, Lawrence; Edwin A. Popenoe, Topeka; W. K. Kedzie, Manhattan.

COMMISSIONS.

Geology—H. C. Hovey, Kansas City; B. F. Mudge, Manhattan.

Entomology—Frank H. Snow, Lawrence; Edwin A. Popenoe, Topeka.

Language—D. H. Robinson, Lawrence; J. H. Lee, Manhattan.

Ethnology—H. B. Norton, Emporia.

Engineering—F. W. Bardwell, Lawrence.

Meteorology—John D. Parker, Wyandotte.

Botany—J. H. Carruth, Lawrence; John Wherrell, Leavenworth.

Mineralogy—W. K. Kedzie, Manhattan.

Chemistry—G. E. Patrick, Lawrence.

Mammalia—M. V. B. Knox, Baldwin City.

COMMITTEE OF LOCAL ARRANGEMENTS.

P. McVicar, Topeka; Edwin A. Popenoe, Topeka; A. H. Thompson, Topeka.

The Society adjourned to meet at Topeka;—the time of meeting to announce.

## SUGGESTIONS ON THE TRUE THEORY OF NUMBER.

BY F. W. BARDWELL.

No one will question the importance of a correct theory of number, though many may be surprised at the suggestion that the current theories are imperfect in any important feature.

It is however true that there is a widespread dissatisfaction with the books which treat of the elements of number; that there are frequent changes in the text-books used in the schools; and that educators, and the friends of education, often complain of the small results of the great amount of time and effort expended in the department of mathematics, and especially given to arithmetic.

These facts justify at least an inquiry in regard to the fundamental theory of number on which methods of instruction properly rest.

### WHAT, THEN, IS NUMBER?

If, as some allege, no formal and perfect definition can be given, yet by means of careful study we should be able to talk intelligently about it, and be able to say confidently, *"this" is number, or "that" is not number.*

Mill says in his System of Logic: "The fact asserted in the definition of number is a physical fact. Each of the numbers two, three, four, etc., denotes physical phenomena and connotes a physical property of those phenomena. Two, for instance, denotes all pairs of things, twelve all dozens of things, connoting what makes them pairs or dozens; and that which makes them so is something physical, since it cannot be denied that two apples are physically distinguishable from three apples, two horses from one horse, and so forth; that they are a different, visible, and tangible phenomena."

### NUMBER USED TO DESIGNATE HOW MANY.

Perhaps it will be admitted that one of the first and most obvious uses of number is to distinguish or define *how many* things are thought of. It may or may not be in answer to a question. In either case, the term called *number*, completely fulfills the function of telling *how many.*

Does number do anything more than tell how many? It appears not. If not, let number be defined as *that which expresses how many things are thought of*, and let this definition be accepted until some defect be found, or until some better definition be invented.

### TWO CLASSES OF NUMBERS.

If there be a group of oranges, consisting of three whole ones and a half of one, that is, one of two equal parts of a whole one, then to describe how many are in this group one would say *three-and-a-half*, and this term obviously performs the same kind of office which in other instances is performed by the term *three*, or by *four;* in other words, it completely fulfills the office of number, and should be included under the name. The same may evidently be affirmed of *one-half* or *three-fourths.* Either may be used to express how many, as one may say "I have ten dollars," while another states "I have *three-fourths* of a dollar," or still another says "I have *one-half* a dollar." It appears then that number may be affirmed of *whole things* or *parts of things*, and this suggests two classes of numbers, one denoting whole things, the other denoting parts of things, called respectively integral and fractional numbers.

To many, no doubt much of the foregoing seems so obvious as scarcely to merit a statement, yet recently an advanced college class in mathematics were puzzled by the quesion, "is one-half a number?" and the opinions were divided, though a majority thought *not.* The same question propounded to a large convention of teachers, caused a nearly equal division in the opinions expressed, while afterwards an able mathematician, widely known and admitted to be such, expressed serious doubt in regard to the matter, though finally admitting the view here expressed.

The facts just stated, indicate not so much a superficial acquaintance with the subject, as the imperfection of the current methods of presenting the elements of numbers, which should leave such confused notions in the mind, even after subsequent progress had made the problems of the higher mathematics quite familiar. One objected to the existence of fractional number, because "there cannot be such things as three-and-a-half men, or four-and-one-fourth sheep." To this it may be answered, that fact simply indicates a feature in the constitution of men and of living beings, which does not permit the existence of life in fractional parts, but in no wise does it impair the flexibility of number which is applicable either to wholes or parts.

In this connection, a practical suggestion occurs, which seems worthy of consideration. Since integral and fractional numbers are two classes of number in general, the exposition of the elementary operations should be applicable alike to both these classes: for instance, the definitions of multiplication and of division should be such as to apply to either integral or fractional numbers. By such means it is believed that the subject of

fractional numbers may be divested of much of the difficulty usually encountered by the teacher as well as the pupil.

DISTINCTION BETWEEN NUMBER AND QUANTITY.

Much confusion seems to exist in the minds of many in regard to the notions of number and quantity. This is partly due to the intimate relation of the things, and partly due to the failure of mathematical authors and writers to make the proper discrimination.

The definition of number is often stated to be "the ratio of two magnitudes or quantities," or, it is said, "number is a unit or collection of units of which one is any magnitude assumed as a standard of measure." In making such statements, authors appear to make number depend upon quantity for its existence, and indeed it is sometimes said, quantity includes both *space and number;* from which it would follow that number is simply one of the kinds of quantity. Professor Olney says "quantity is the amount or extent of that which may be measured." It seems, however, a better statement to say, quantity expresses the limit of magnitude or extent; in other words, *quantity expresses "how much."*

The difference between number and quantity is precisely of the same kind as that between the notions of *much* and *many.*

It is noticeable that in the form of words, the comparatives of much and many are identical. Thus we say *much, more, most,* and we say, too, *many, more, most;* but the notions of more and most in one case differ from those in the other case in the same way that much differs from many; that is, in the first case more and most relate to quantity, while in the second case they relate to number.

This use of one word to express two ideas or notions, which though related are yet distinct, indicates some confusion in the minds of those whose use of words has given form to our language; but this fact scarcely excuses at the present day any failure on the part of authors and instructors to make the proper discrimination.

In the French and German languages the distinction is less marked than in the English; and so in the Latin, *multus* and *multi* (much and many) differ only in singular and plural forms of the same word. The same is true of the Greek.

NUMBER USED IN THE MEASURE OF QUANTITY.

It follows from the foregoing that it is incorrect to say "number is quantity," though number is often used in *measuring* quantity. It is, in fact, seldom that a quantity is measured in any other way than by meaning the *number* of standard units of quantity contained in the quantity to be measured. For instance, four feet, twelve bushels, twenty acres, illustrate this statement. Yet this fact, though it indicates an important use of number, still does not constitute the basis of a definition, and should not be so misused.

IS MATHEMATICS THE "SCIENCE OF QUANTITY?"

This statement, which has become stereotyped, fails to perform well the office of a definition, even if it does not fail to express the literal truth. The vague use of the term *"quantity"* unfits it to appear as the essential part of a definition. In algebra the current use of this term makes it almost equivalent to the term number, or *symbol of number.* It should be remembered that all algebraic operations are upon number. Thus there can be no multiplication of quantity by quantity: strictly speaking, all multiplication is *purely* by number; and it would seem better in a science, one of whose chief excellences is *precision,* to call things by their right names. It is believed that a careful consideration will convince any one that all the symbols of algebra are either the symbols of number or of the relations *of* and operation *upon* number. In the application of algebraic principles to problems of quantity, we deal only with the *measure* of quantity in the guise of number. In the elements of geometry, the symbols of magnitude are presented for direct consideration; but in the higher geometry the investigations are made chiefly by algebraic methods; that is, by using the symbols of number to represent the measures of quantities. The statement that mathematics is the science of quantity seems then to be an incomplete definition, if in any true sense it can be called a definition.

ABSTRACT AND CONCRETE NUMBERS.

Perhaps the frequent occurrence of these terms forms a sufficient reason for noticing them in this connection. Number in its very nature is abstract, and it is an obvious misnomer to call it *concrete* in any case. Two means *two things*, and though the kind of things is not explicitly named, the essential character of number is not affected. The statement "two and three are five," means merely "'two things and three things counted together, are five things." It may be mentioned in passing, that since the office of number is exclusively that of fixing a limit of "how many," the greater or less extent of "how many," does not at all affect the character of the number applicable to the particular case. Thus the number two or three, possesses as completely the character of number as *a thousand* or *a million*. It follows then that *zero* or *naught*, when used, as it often is, to designate the limit of "how many," is properly included under the name number. It is believed that this consideration is not only logically consistent, but that it simplifies the use of *naught*, as well in arithmetic as in algebra, where it often appears as the root of an equation, and in many instances performs as conspicuous and important services as are assigned to any number.

The necessarily brief limits of the present paper do not permit a further examination of these questions at this time; but it is believed enough has been said to show that a thorough revision of the fundamental theory of number is required in order that this branch of instruction should not fall behind in the developments of the day.

## ANALYSIS OF CLAYS.

The following brief notes of qualitative and quantitative analyses, taken from my laboratory record, will be of interest to some, and give a general idea of the chemical composition of some of the clays found in so great abundance in this State.

In this form of mineral wealth, Kansas is rich, the list embracing every variety in inexhaustible quantities, from pure white porcelain clay to common marl, and in time it must develop a large and varied manufacturing industry.

Many of you have heard of the Osage City ochre, which is found in an immense bed, varying from twelve to twenty-four feet in thickness. Its composition is—

| | | | |
|---|---|---|---|
| Silicate of Alumina | Nearly 98 per cent | Silicate of Magnesia | Trace |
| Silicate of Lime | Small amount | Sesqui-oxide of Iron | Small amount |

In that portion of the bed worked at the present time, the percentage of oxide of iron is a little larger than the sample gave from which the analysis was made.

At Council Grove is found an ochre with the same constituents:

| | | | |
|---|---|---|---|
| Silicate of Alumina | Large amount | Silicate of Magnesia | Trace |
| Silicate of Lime | Small amount | Sesqui-oxide of Iron | Moderate amount |

This ochre has exactly the shade of the *Spanish brown* largely used as a mineral paint, and is in every way equal to it.

The extent of the deposit, its geological position, and its physical characters, I do not know.

Over the eastern half of the State are distributed strata of a light, bluish clay, varying from one to two feet in thickness, lying immediately over or under the coal, commonly called fire clay, but none that I know of are sufficiently pure to furnish first-class refractory fire brick, suitable for furnace linings. Some sufficiently pure, however, will, I believe, eventually be found. Clays sufficiently pure for the manufacture of stone-ware, and other articles that are not required to resist an intense and prolonged heat, are known.

A so-called fire clay found at Council Grove, contains—

Silicates of Alumina and Iron. | Carbonate of Lime. | Sulphate of Lime. | Chloride of Calcium. Carbonate of Magnesia.

The two following are found at Carbondale, No. 1 above a coal bed, No. 2 beneath it:

| | *No. 1.* | *No. 2.* |
|---|---|---|
| Water, given off at 212° F | 8.50 | 3.00 |
| Organic matter | 2.00 | 2.00 |
| Silica | 27.50 | 48.60 |
| Alumina | 39.50 | 21.35 |
| Protoxide of Iron | 18.05 | 16.70 |
| Sulphate of Lime | 3.90 | 6.80 |
| Sulphate of Magnesia | 0.55 | 1.05 |
| | 100.00 | 100.00 |

These last from Carbondale are good average samples of the so-called fire clays of Eastern Kansas.

Recently there has been discovered on the line of the K. P. R. W. a beautiful pure white porcelain clay, that remains perfectly white after being subjected to a strong heat. It is apparently pure enough for the manufacture of a fine quality of porcelain, and for many other uses in the arts. The deposit is said to be extensive, uniformly pure and easily worked, characters which, if true, make its great value fully assured. Its composition is—

Silicate of Alumina. | Silicate of Lime (a trace). | Peroxide of Iron (a trace).

A very pure sample of native rock salt was brought me from the southwestern part of the State, consisting of—

| | | | |
|---|---|---|---|
| Chloride of Sodium | 92.20 | Sulphate of Soda | 4.91 |
| Chloride of Magnesium | 0.81 | Silica | 2.08 |
| | | | 100.00 |

The locality from which it was taken, and the extent of the deposit, are unknown to me.

The following analysis will be of general interest, as it shows how powerful diaphoresis can remove from the body by perspiration, mineral compounds that are not ordinarily eliminated through the skin. A gentleman who had been suffering for three years from general debility, decided to try the effects of the Turkish bath. After a few trials finding his condition improved, he desired to know whether any noxious mineral matter was being eliminated by the sweating process, and brought me a sample of perspiration for analysis. After standing a few hours, a residue settled, which was examined separately. The result was as follows:

FILTRATE.

Reaction neutral. | Water. | Organic matter. | Chloride of Sodium. Sulphates of Soda and Potassa. | Phosphate of Lime.

RESIDUE.

Organic matter. | Alumina. | Sesqui-oxide of Iron. | Phosphate of Lime.

Attention is called to the presence of alumina, sesqui-oxide of iron, and phosphate of lime, substances that we would not expect to find in perspiration, and which ought not to be eliminated from the system faster than they are naturally excreted. This case must be an exceptional one, I think, as the Turkish bath, for properly-selected cases, is a valuable tonic and remedial agent, that invigorates the system, not a debilitating agent that abstracts the sources of its vitality. WM. H. SAUNDERS, M. D.

LAWRENCE, October, 1874.

## A GEOLOGICAL SURVEY OF KANSAS.

We have an area of territory ten times as large as Massachusetts (78,000 square miles) much of it only yet visited by the hunter, and the geological character of even the settled portions but little understood.

Enough coal exists, at least for a home supply for ordinary domestic heating purposes. But even when valuable for generating heat, how much is known in relation to its worth for making gas, smelting iron ore, or for the common uses of blacksmithing?

We have, if we believe the newspapers, plenty of magnesian limestone in all parts of the State; but who knows how much or how little of it has any magnesia in it, or whether it has any of those properties which make true magnesian limestone available for hydraulic or Roman cement? We have, on the same authority, plenty of slate; but how many know if it is the genuine article? We might go on asking the same questions about a dozen other products found, or said to be found, in our State.

Much time and money are being expended in the useless search for metals, when only two—iron and lead—can by any possibility be found in the State, and those in a narrow area, where the chances are very strongly against us. We have coal in half the counties of the State, but a considerable portion is utterly worthless. Much is frequently worked and carried to some adjoining market, only to disappoint both the miner and purchaser. At the same time our best coal seam, which would be counted good in Pennsylvania, is little worked and less known, than the inferior article. We hear of constant expenditures in boring and digging for coal, where a geologist could easily decide that no coal could be found. Enough has been spent in half a dozen Kansas cities, ignorantly and uselessly searching for coal, to pay for a full, economical and scientific survey of the State. We cite one example for illustration: A city with more enterprise than confidence in geology, though frequently advised by me that no paying coal lay within one thousand feet of the surface, commenced the search, boasting through the press that the proceeding was "contrary to all principles of science,"and "against the advice of one of the best geologists in Kansas," adding, "but we have got the coal." After boring three hundred feet, and striking dark shale, a shaft was opened at an expense of over $25,000, only to find a black, worthless substance, which was not coal, and would not burn. Council Grove is not the only place in Kansas that has spent capital to bore for coal "contrary to all the principles of geological science." A few such expenditures as the above would be all the most extravagant geologist would require for a full, scientific survey of the entire State.

Other articles beside coal, require investigation. Our gypsum is abundant and valuable, but almost unknown to our citizens. Salt is found in large quantities, but only the small deposits of weakest brines are yet worked, while this valuable article is brought a thousand miles to our market. We should, instead, be sending our very superior salt to all the neighboring States.

Nor should the scientific aspect of the survey be overlooked. We have a flora in many respects unlike the more easterly portions of our country. We want a knowledge of our insects as well for science as the farmers. The chemical analysis of our soils and building materials and few minerals, is equally important to all. Our fauna is peculiar, and some of it rapidly disappearing. We have some geological formations (Permian, for instance) little represented in the United States; and others so rich in new forms of ancient life, that Eastern colleges and institutions are procuring them by tons, and we, in future, may be obliged for our collections to glean from their leavings. Kansas has probably presented to science, during the past eight years, more new species of fossils than any other State in the Union. And this only by the unaided labors of private enterprise. Much more could be done by a little State aid, and the specimens and credit preserved for Kansas. We should not be behind other States in this respect. Not only are Missouri and Iowa leading us in this matter, but many of the Southern States have organized, or are organizing, their geological surveys. We should not be less enterprising. We cannot promise the discovery of any precious metals as the result, yet a knowledge of the mineral contents of our strata will richly repay the small cost necessary. No better advertisement can be made to draw emigration, than a geological report. A true knowledge of the geological character of Kansas should be sent abroad. While writing this article, an official document from the National Land Department at Washington comes to me with a most gross misstatement of our coal fields. Such errors should be corrected by official reports from home. Nothing would so economically prevent the useless waste of

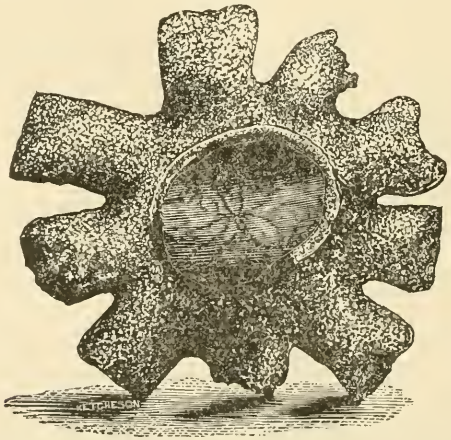
time and money in search of possible products of the soil. The saving to the people at large would, in this respect, be ten-fold, and from the pockets of those who can ill afford the expense.

## BRACHIOSPONGIA.

BY REV. HORACE C. HOVEY, M. A.

During a geological trip in 1855, I discovered a new genus of fossil sponge, which, although extra-limital, may be worthy of a brief notice. My first specimen was exhibited to Prof. L. P. Yardell, of Louisville, Kentucky, and while in his hands it was seen and described by Prof. D. D. Owen. (Second Report of Geology of Kentucky, p. 111.) He styled it an amorphozoon, and suggested the name of "*Scyphia digitata.*" I doubt if he ever saw the fossil in place, though he correctly refers it to the Bridseye group of the Lower Silurian. It was again described and imperfectly figured by Prof. R. Owen. (Indiana Geological Survey, 1859–60, pp. 362, 363.) He changed the name to *Syphonia digitata*, and he recognized it as a sponge. The specimen thus described, having nine arms, I claim as my discovery, and it should be acknowledged as typical of the genus. Prof. S. S. Lyon afterward found one with eleven arms, of which casts have been widely distributed. In 1867 I placed my original specimen in the hands of that accomplished naturalist, Prof. O. C. Marsh, of Yale College, for a more careful examination. The result was the rejection of the former unsuitable names and the substitution of *Brachiospongia* (the arm-bearing sponge), with the specific name of *Romerana*, in honor of Prof. F. Roemer, the leading authority on paleozoic sponges. Over fifty additional specimens, complete or fragmentary, were obtained by me on a subsequent visit to Franklin county, Kentucky, and a map of the sponge region was prepared. Specimens have also been found in the same geological horizon in Tennessee. Allied forms were likewise found, but they were so highly silicified and distorted as to make an accurate description impracticable. Prof. Marsh's notice appeared in the *American Journal of Science and Arts*, vol. 44, p. 88; and it was afterward corrected and elaborated in the form of a paper read before the American Science Association in 1868. Figure 1 represents *B. Roemerana.*

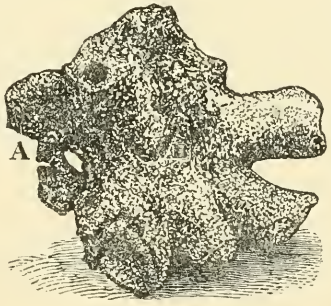
[Fig. 1.]



The general appearance of the *Brachiospongia* is vasiform; a central cup, oval, with a rim one or two inches high, being surrounded by tubular arms or fingers, hollow at the base, and closed at the extremity. These arms vary in number, from five to twelve; and on this variation specific distinctions are founded. The smallest sponge of this kind thus

far found is three inches in diameter, and the largest, twelve inches. Frequently the fingers were found detached from the body; and in one case two large ones were found near each other, having so grotesque a resemblance to a pair of diminutive human feet that for a time my assistants positively refused to aid me further! The exterior of the *Brachiospongia* is silicified, while through the interior characteristic silicious spicules are distributed. Near the center of the base, and opposite the mouth of the cup, is a small papilliform cone, which others have regarded as the point by which the sponge was attached to its support. But, in my opinion, this is a hasty conclusion; and I think it can be shown that this basal protuberance is the remnant of a partially absorbed arm. In a specimen of *B. Hoveyii* (Marsh), having twelve arms, only six of which appear in the figure (see fig. 2), there is evidence that the sponge arms, though constant in their specific numbers, were at intervals liable to alternate absorption and reproduction. The arm, marked A, seems to be the youngest in a series of which the basal cone, marked B, is the retiring member. A more careful study of these curious and highly interesting fossils may serve to throw light upon the mysterious laws of spongoidal growth.

[Fig. 2.]




## DISCREPANCIES BETWEEN THEORY AND OBSERVATION OF THE MOON'S MOTION.

BY F. W. BARDWELL.

In studying recently the question of the moon's irregularities, I discovered an apparent source of error affecting lunar computations, whose explanation will probably interest many scientists, though of more special value to the astronomer.

The problem of the moon's motion has been one of the most interesting, though troublesome, in the series which astronomers have attacked with such success, as one by one the difficulties have been overcome, and the victors received their well-earned honors. Yet it is well known that the differences between the predicted and observed places of the moon are greater than in the case of any other heavenly body, and that these discrepancies have excited the special efforts of investigators.

Thus a comparison of the Washington observations with the American Ephemeris for 1870, indicates errors in the predicted right ascension of the moon, extending from $+0.^s4$ to $-0.^s7$.

Among the interesting phenomena dependent upon the motions of the moon, lunar and solar eclipses are conspicuous, and observations of these have naturally been used in the determination of elements or in the verification of theories, and any error pertaining to such observations would serve to introduce error into lunar tables.

An eclipse of the moon occurs when she passes into the earth's shadow, and the axis or central line of the earth's shadow is usually reckoned as the prolongation of the line

connecting the center of the sun with the center of the earth. But this supposition contains an appreciable error. For since light requires an appreciable extent of time to pass from the earth to the moon, the earth advances in her orbit during that small interval, so that the part of the shadow found at any distance from the earth, say at the moon, lags a little behind the corresponding place of the earth.

It may easily be shown that the axis of the earth's shadow thus lags by an angle of about 20″—equal to the angle of aberration—and as the entire cone of shadow tends to lag equally in angular measurement, it will follow that the eclipse will begin and end earlier than if the earth's shadow were projected directly behind itself.

In other words, the central moment of a lunar eclipse does not coincide with the instant of the moon's opposition, but differs by the time required for the moon to gain about 20″ relatively to the earth's position in her orbit, which may be 40 or 50 seconds of time or more.

In the case of a solar eclipse, some of these relations are reversed, though the result is nearly the same. Considering the motions of the earth and moon with reference to the sun, the moon is first in advance of the earth, while the earth is gaining upon her, but as the moon's shadow lags also, so the earth encounters it earlier, and by nearly the same interval of time, as happened in the case of the lunar eclipse, and the central moment of the solar eclipse occurs before the instant of conjunction.

It follows, then, that a lunar theory which includes the supposition that the central moments of lunar and solar eclipses indicate the instants of opposition and conjunction must involve an appreciable error, which would affect the tables based upon it.

It is noticeable that the error here pointed out—20″ in longitude—corresponding to about 1.$^s$3 in right ascension, expresses so nearly the range of the discrepancies between the lunar tables and the results of observation.

Whether the elimination of the effects of this error would serve to reconcile completely theory and observation, can only be decided by actual experiment, but it seems reasonable to expect much from such an elimination.

The lagging of the shadows suggests other curious deductions, which may be mentioned:

When the transit of Venus occurs, she will not, in the ordinary sense of the word, be *seen* upon the disc of the sun, but she will intercept certain rays of light, while only the *place* of the intercepted rays is perceived. But the place of these rays, or the shadow, lags, and, since the velocity of Venus is greater than that of the earth, the angle of lagging is greater than in the case of the earth's shadow. It will happen, then, that Venus will be in a line with a tangent to the sun and earth several minutes before an observer on the earth can perceive the indications.

If Venus were able to shine and make her light perceptible while passing in front of the sun, she would be perceived sooner than will actually be the case, and all the circumstances of the transit will appear later on this account.

The angle of aberration due to the velocity of Venus is about 24″, and, since this measures the angle of lagging, the shadow will not overtake the earth until Venus shall have advanced about 24″ past the line of tangency. The hourly motions being respectively $-$ 10.$^s$980 and 6.$^s$267 in right ascension, it will require about five minutes to accomplish the passage, and this interval indicates the apparent delay that may be expected.

Again, in the case of the solar eclipse, the absolute velocity of the moon is less than that of the earth, by a difference due to the velocity of the moon about the earth, which may be determined with a good degree of accuracy. The angle of lagging will, therefore, be less, and the time occupied by the earth in gaining it will also be less, so that the change in the angle of aberration, due to the velocity of the moon about the earth, will be indicated on a magnified scale.

The ratio of this change to the entire angle of aberration would again indicate the

absolute velocity of light, knowing which, and the time occupied by light in coming to us from the sun, the distance of the sun becomes determinable.

The value of this method of determining the solar parallax will depend upon the precision of the lunar tables, but, with the elimination of the effects of the error above explained, it is possible such precision may be attained as shall make the method valuable.

The comparative frequency of eclipses would enable astronomers to accumulate observations rapidly, and the more rapidly reduce the degree of error.

POSTSCRIPT.

The foregoing remains the same as originally prepared, though from further inquiry it appears that in the case of the lunar and solar eclipses *apparent* instead of *true* geocentric opposition and conjunction are understood in the elements given in the Nautical Almanac for those computations, so that no error in the moon's place could thus occur. A similar remark applies in the case of the transit of Venus.

The fact of the lagging of planetary shadows, seems, however, to deserve recognition, though it furnishes no aid in the attempt to diminish the discrepancies between lunar theory and observation. And though these discrepancies are still so great as to indicate a specific cause which has so far eluded discovery, it is yet reasonable to believe that the true cause lies within the operations of known law; that this cause will ultimately be found out, when the moon will appear to move completely subject to the law of gravitation, and will conform gracefully to the predictions of astronomers.

LAWRENCE, KANSAS, December 7, 1874.

## ON TIN "SALTING" ENTERPRISES IN THE UNITED STATES.

BY PROF. WM. K. KEDZIE.

Among the many elements which enter into, and add to the completeness of what we in egotistic phraseology term "our modern civilization," there are many most vitally important in their relations to the wants and necessities of civilized life, for which modern civilization is in no way responsible. They are the product, not of modern enterprise or industry: on the contrary, they are an inheritance, handed down to us from a remote and barbaric past.

Not the least important in its multitudinous and vital relations to the usages of civilized life, and for which we here to-day are mutually debtors to *pre*-civilized enterprise, may be mentioned the metal, TIN. The mere mention of the metal calls up before us the thousand-and-one uses and purposes which it subserves in every-day life. Whether in the form of block-tin, or as a coating to inferior but more durable metals, such as iron or copper, or in the beautifully semi-crystalized condition known as *moiree metallique*, or in the form of foil of one one-thousandth of an inch in thickness—so indispensable in the manufacture of mirrors; its brightness and beauty, almost equaling that of silver; its durability in air at ordinary temperatures—all conspire to render it a metal of incalculable value in the manufacture of articles of ornament and of every-day use.

And yet indispensable as we in this age and country have learned to regard this metal, it is interesting and instructive to note how little actual progress in the mining and metallurgy of tin has been made in the last three thousand years. For by this you will see that I place the discovery and first manufacture of tin from its ores, at a point far antedating the birth of the Christian era. No learned savant in the old world of alchemy has been able to hand his name down to posterity, linked with so all-important a discovery.

To give the exact date of the introduction of tin would be quite as impossible and as difficult as to name the discoverer of gunpowder, or of the manufacture of glass. In the books of Moses we are told at one point of the "gold and the silver, the brass and the *tin*." Under the cabalistic sobriquet of *Kassiteros*, Homer sings of it in the Iliad, as that which gave strength and splendor to the battle-shields of Trojan warriors. By the writings of Pliny and others, we know that as early as between the years 1030 and 1040 before the birth of Christ, the Phœnicians had begun to avail themselves of the immense tin deposits of Cornwall, in the British Isles. And strange as it may appear, these same old mines of Cornwall, after 3,000 years of hard usage, are still the great tin producers of the world, giving us annually from their apparently inexhaustible resources 140,000 hundred-weight of the pure metal. Since the time when the Phœnicians began the transportation of this metal across the English Channel, how comparatively little has been accomplished in the new discovery and development of tin deposits. To be sure, we now have the mines of Banca and Malacca, yielding their annual 100,000 hundred-weight. Then, too, there are the remarkable mines of Bolivia, the reported yield of which has however, in all probability, been greatly exaggerated. Then may be enumerated the lesser deposits of Bohemia, Saxony, and Australia, and associated with the mineral Cryolite ($Al_2F_3,3NaF$,) to some considerable extent in Greenland. The Australian tin ore contains also so large a percentage of gold that it may be extracted with profit. Within the past year also a new deposit of most promising character has been discovered upon the MacIntyre river in Australia, which bids fair to rival either Cornwall or Banca in its wealth.

The remarkable absence of anything approaching the character of tin deposits in the United States has been a most unwelcome fact which has long perplexed mineralogists. Not that the mineral *Cassiterite* or *Tin Stone* is entirely absent; for very slight deposits may be found near the town of Chesterfield, Pa.—associated with albite and tourmaline —also near Jackson, N. H., Paris, Maine, in the gold fields of Virginia, in Idaho, and in California. But in all these localities the metal exists only in such quantities as to be purely of mineralogical, never of metallurgical importance. It is but proper to remark, however, that the supposition is entertained by some that the deposits of San Bernardino county, California, may yet prove of commercial interest, when more fully examined.

Now in a territory so richly endowed as is that of the United States, with all the mineralogical wealth that the needs of a high civilization could demand, this lamentable poverty in the matter of tin deposits evinces an unwarrantable short-sightedness on the part of nature. To be compelled to resort to our more favored English brethren on the other side of the Atlantic for a requisite supply of the needed metal has long been a subject of national chagrin. This impoverished condition of our tin resources has plainly been long felt by American patriotism as a great and a national reproach upon the character of a progressive commonwealth! At least upon no other adequate basis can we explain the efforts to supply this deficiency by the innumerable *tin-salting enterprises* which the last twenty years have witnessed in this country, some of which have been conceived and carried out upon a stupendous scale and with unfaltering energy. It is among these undertakings that the recent "tin mountain" excitement in Missouri may be classified; in some respects one of the most laughable instances in the whole calendar of tin frauds, closing with a grand railroad excursion, in which a credulous public is said to have stood gaping around two chemists, who were supposed to have produced the metal from a rock about as destitute of true cassiterite (tin stone) as a specimen of Jura limestone!

It is among these instances that these isolated "tin discoveries" are, even in our midst in Kansas, constantly taking place. I am in constant receipt, at my laboratory, of packages of ore from various parts of the State, supposed to abound in tin. Not infrequently a neat little ingot of the pure metal, said to have been found in close proximity to the ore, accompanies each package—the discoverer evidently forgetting that pure tin is one of the rarest elements in the whole realm of mineralogy. But it is to one of these enter-

prises in particular, even now in progress, and which can hardly be considered other than a case of "salting," that I desire to-day to call your attention, having been myself an amused spectator of the undertaking. I refer to the "Otter Head Consolidated Tin Land Pool" of the region north of Lake Superior. The marvelous accounts of this territory report it as furnishing not only the sulphide of tin, ($Sn\ S_2$ generally combined with sulphides of iron and copper,) which has hitherto been known only in Cornwall, England, where it passes under the name of bell-metal ore, but in addition also an abundance of the genuine Cassiterite—tin-stone ($Sn\ O_2$)—in all its forms of hard, brown-black, glittering octahedral crystals: before the blowpipe alone infusible, but readily yielding globules of metallic tin when fused upon charcoal with a flux. The modifications of Cassiterite are also said to be here afforded in their various botryoidal forms known as "wood-tin" and "toad's eye," from its peculiarly concentric and radiated structure; and last but most incredible part of the whole account, *native* or *metallic tin*, which heretofore has been known only as an exceedingly rare native metal, found occasionally in the gold washings of Boliva and in Siberia. Early in the past year an elaborate article appeared in the New York *Herald*, giving an account of the supposed discovery of these mines. It seems that some years ago, off the entrance to Thunder Bay, on Lake Superior, the famous Silver Islet was discovered, which now, under the direction of a large company, is yielding an immense profit. Stimulated by this discovery, the whole north shore of the lake was soon covered by earnest explorers. As a portion of the fruit of their investigations, gold in quartzose rock was said to have been found in the region about Shenandowan Lake, though in consequence of an unsettled dispute between the provinces of Manitoba and Ontario as to the right and title of the land, the discovery was maintained a profound secret. A portion of this same party of discoverers, operating in other directions toward the south and east, reported themselves as finding, in the immediate vicinity of Otter Head, on the Canada shore, extensive veins of dark-colored ore of a high specific gravity, specimens of which they brought with them on returning. These specimens are filled with well-defined crystals of Cassiterite, which may readily be detected with a glass of low magnifying power. Upon assay they yield an abundance of metallic tin. It is said that the discoverers first supposed them to be iron ores, on account of their dark color, but the assay failed to yield metallic iron in sufficient quantity to account for their high specific gravity. A white metal was also produced as a part product of the assay, and was at first taken to be silver, as silver was the metal they were seeking. A more critical examination, however, proved this product to be metallic tin.

This valuable metal being heretofore supposed to be an utter stranger upon this continent, this supposed discovery created, as might have been expected, much comment and an unusual degree of interest. No more propitious a locality for such a venture, supposing it to be a fraudulent one, could have been possibly conceived. Around the exact point of the so-called discovery, at Otter Head, about midway between the canal of Sault Ste. Marie and Thunder bay, the country is eminently wild, solitary and romantic. Heavy granite cliffs rise from the shore of the lake to the height of a thousand feet. A few wandering Chippewa Indians may be found in the district, but not a white man can be seen within fifty miles of this point. From the extremely precipitous character of the territory, extensive inland travel is an utter impossibility; hence, much of the exploration must be confined to the lake shore. Early in May, 1873, I received from the secretary of the "Otter Head Tin Pool" a considerable quantity of the ore, accompanied by a printed pamphlet embodying the report of the trustees of the company. The ore was certainly of an unexceptionable character, dark-gray in color, and heavily charged with crystals of Cassiterite. Much of it was in the condition called stream tin—a rich, fine ore, produced by the washing action of running water. It yielded on assay from fifteen to thirty-five per cent. of clean metal. This ore was also remarkably free from the inju-

rious mineral Wolframite (tungstate of iron and manganese (Fe Mn) $WO_4$), from which, as its specific gravity is nearly the same as that of Cassiterite, it is frequently extremely difficult to separate the ore. I also forwarded specimens of the ore to Prof. O. D. Allen, of the Sheffield Scientific School of Yale College, who stands as the acknowledged head of American metallurgy. He pronounced the specimens rich in tin, but at the same time intimated to me his suspicions that the enterprise was a "salted" one. Dr. John Torrey, of the United States assay office at New York city, before his death, also assayed the ore, and reported as follows: "The ore is a true Cassiterite, or tin-stone mixed with quartz; some of it is massive, but a considerable portion of the examined specimen is in the form of small, translucent, quadrangular prisms, some of which are perfectly terminated. The average of the samples yielded 33.3 per cent. of metallic tin." Similar assays were also made by Dr. Jennings, of Detroit, and by Drown and Carliss, of Philadelphia, all testifying to the promising character of the ore. When we remember that pure Cassiterite itself affords but 78.38 per cent. metallic tin, we can better appreciate the rich results obtained by Dr. Torrey.

Stimulated by these flattering indications, the company already designated as the "Otter Head Tin Land Pool," was organized, a tract of land to the extent of 28,314½ acres was purchased, shares issued and thrown upon the market, and, as may be supposed, were for a time in ready demand. In the report of the trustees of this organization are displayed apparently well-authenticated accounts of individuals exploring this region. The veins are described as well defined, and fully five hundred in number. Their courses are said to be generally well marked from northeast to southwest, with a dip of eighty degrees to the south. In width they are said to vary from an inch to six and eight feet, and to extend miles inland. The veins are also said to cross each other, forming at their intersections deposits designated by the Germans as *stockwerk*. The value of the dressed ores, as given in the report, is estimated to vary from $23 to $369 per ton. But notwithstanding all these very promising indications and the apparently frank and minute statement of details, many doubtful circumstances soon created suspicion that the whole enterprise was a "salted" undertaking. Time has only served to confirm this suspicion in the minds of many, and the market value of the stock is now immensely depreciated. If such should prove to be the case, the query now arises, From whence was this rich ore obtained? Rumors have reported the finding of the boxes and barrels in which the ore was supposed to have been transported, in close proximity to the so-called veins; and also of the vessels in which the metallic tin was melted and judiciously distributed, though the latter can hardly be accredited. But let us remember that such an undertaking by no means argues a dishonest purpose in the minds of many or even most of those engaged therein. This consolidated Tin Land Pool numbers among its members many sincere and honorable men, who are now extensively purchasing the stock at its greatly depreciated value. But let us also bear in mind that the problem of deceiving even skilled metallurgists is by no means a difficult one. How much more easily, then, may those be misled who are unschooled by experience in mining matters?

The chemist, in collecting his specimens from the mine which he is called upon to examine, gathers them in small canvas bags. These, speedily becoming too heavy for convenient transportation, are deposited at convenient points, to be collected at the close of the exploration. How easy to replace them by similar bags containing a far richer ore! It was by this very process that an Eastern capitalist was recently very nearly swindled out of $206,000 by the analysis of his own chemist.

In conclusion, then, until the "Lake Superior Tin Land Pool" shall have given us abundant pledges of its good faith in the form of ingots of fine tin thrown upon the market, we cannot do otherwise than number it as one of the great fraudulent enterprises of the age.

K. S. A. C. CHEMICAL DEPARTMENT. October, 1874.

## PLIOCENE TERTIARY OF WESTERN KANSAS.

BY B. F. MUDGE.

The Tertiary deposits of Western Kansas have been but little examined, and consequently our knowledge of the peculiar character of its geology is quite limited. The exceedingly rich and varied fossils of the Cretaceous (Niobrara group), immediately under it, have probably led to its neglect. Even its extent has hardly been noticed. Professors Cope and Marsh have both in their visits to the Cretaceous made some casual notices of it, without spending much time in searching for its fossils. The writer, in the summer of 1872, spent a fortnight in its examination in the vicinity of Prairie Dog creek, but as the deposit was there very barren of organic remains, little satisfaction was obtained. During the past summer and fall we have been engaged in careful exploration of the Cretaceous, lying immediately under it, and consequently have seen it over a wide extent, and found its fossils more numerous and more varied in character than we had at first supposed.

In tracing its limits, we find it most easterly in the northern part of Smith county, where it is seen only on the tops of the highest hills. Its position there as elsewhere is very nearly horizontal, but usually dipping slightly (not more than five or eight feet to the mile) northwesterly. As the country rises about eight feet to the mile toward the headwaters of the Republican and Solomon, the deposits in question gradually descend lower down, and in Norton county entirely compose the hills, and fill the valleys and ravines. It then continues to the extreme western boundary of Kansas. Thus it extends on the Nebraska line, on the hilltops of Smith and Phillips counties, about fifty miles, and then, becoming the only deposit seen in Norton and other westerly counties, for one hundred and twenty miles farther, or a total of one hundred and seventy miles within the bounds of our State. Tracing its boundaries southerly and westerly, we find its limits bending rather rapidly toward Colorado.

It is not found in the southern part of Smith or Phillips counties; and in Rooks county, still farther south and west, it is seen only in the western portion, crossing the Solomon on the hills in the vicinity of Logan. From thence it tends more directly south, and is found on all the hills in the northeastern part of Ellis county, on both sides of the Saline river. It does not, however, cross to the Smoky Hill river, twenty miles distant, for the next seventy-five miles. It turns towards Colorado, and is not seen again in the lower valleys, but only as a landmark forming the tops of the hills. In the vicinity of Fort Wallace, it appears south of the Smoky, and is seen occasionally for forty miles south and southeast of that place.

On examination of the country westerly of the boundary given, we shall find that the Pliocene occupies, in common with the Cretaceous (Niobrara group), about one-half of the area of the country for three thousand square miles, while it entirely covers the northwestern part of Kansas to the extent of about twice that number, or six thousand square miles. It will thus be seen that if a geological map were to be made of the Pliocene, its outlines on the east and south would be very irregular; the higher portions of the country presenting the sandstones of the Pliocene, while the ravines and valleys would show the chalky limestones and shales of the Cretaceous.

The fossils which we at first supposed rare in the Pliocene, were found in our later visit more abundant and very interesting. As our labors the past six months were devoted to the collection of vertebrate fossils from the Niobrara, our examination of the former was casual, and only along the line of their union. The fossils of the two were found in situ and within ten vertical feet of each other, and frequently in the shales, mingled together. The contrast is very great. While the Cretaceous are nearly all marine, with no mammals, those of the other are nearly all mammalia of modern types.

The Pliocene gave us bones of deer, beaver, a larger animal of the ox family, two species of horse, less in size than our smallest Indian ponies, a wolf, ivory from the mastodon or elephant, bones of the rhinoceros and camel, also some remains of an undetermined character. In addition to these we have the bones and carapace of a large fresh-water turtle, five feet in length, and a few obscure marine fossils; also what appear to be the casts of stems of water-plants. All these, as may readily be considered, are of extinct species, and some of extinct genera. All the bones are fossilized, and most of them change to hard, compact silica. The most interesting of these is the ivory. In the process of petrifaction, the tusk must have been so softened as to admit the intermixture of black oxyd of manganese* in solution, which then crystalized in delicate sprigs. The ivory was then silicified into nearly pure quartz, with the hardness of that substance. Thus we have the ivory converted to the so-called moss agate. Some fragments could not be detected in appearance from that gem. Specimens of it have been sent to the cabinet of Yale, and a few are deposited in our collection of the Kansas Academy of Science.† The agencies of nature that changed this ivory to a silicious moss agate must have been somewhat similar to the hot springs of Iceland and the Yellowstone Park. Those springs will change organic substances to silica — the only known natural agency which will do so in a thorough manner.

The materials of the Tertiary-Pliocene are in as strong contrast with those of the Cretaceous as are the fossils. While the latter is composed of fine-grained chalk and shales, the former is of silicious sand, in many places intermingled with coarse pebbles of metamorphic rock. For the most part, the sandstone is in a very friable state, crumbling on exposure to the atmosphere; and where it is more compact, its mechanical composition is so irregular as to render it almost entirely unfit for a building material. When firmly consolidated, it forms the tops of the table-like hills of northwestern Kansas. At Bread-Bowl Mound, in Phillips county, it is nearly two hundred feet above the water of Deer creek, and at Sugar Mound, in the western part of Rooks county, which is nearly three hundred feet above the waters of the Solomon, it forms seventy-five feet of the upper portion. Farther west, it occupies the whole of the visible deposit, and the mounds are not so prominent. On Prairie Dog creek, in Norton county, it is about four hundred feet in thickness. Beyond, westward, we have reason to believe that the formation is still thicker. Our time and engagements have never allowed us to visit in the extreme western counties.

The occurrence of moss agates (as they are called) on the plains, in the western part of the State, is well known. Beautiful specimens have been picked up, and are frequently worn as jewelry. As they are found in the loose gravel, they have been supposed to owe their present deposit to drift, their original home having been in the North. But I was somewhat surprised to find that they originated in the Pliocene deposit, within the bounds of western Kansas, near their present position. In Wallace county, this Pliocene consists of a silicious deposit, formed of material varying from coarse flint-quartz, to chalcedony, milk-white to transparent; sometimes presenting a fine semi-opal appearance Oxyd of manganese, more or less crystalized in minute, moss-like sprigs, extend through the whole strata of eight feet. The lower part is formed of the coarser materials, and it is only in the upper six inches that we find any moss agate fit for the lapidary. Some of them are very fine and transparent. The whole mass is extremely interesting to the mineralogist, as showing the moss agate in the whole process of formation. The lower portion indicates an imperfect chemical solution of the silica and oxyd of manganese, therefore the crystalization is imperfect; while the upper inch, or half-inch, contains the best specimens, evincing the deposit in a higher state of chemical development.

The fossil ivory must have been subjected to this same chemical process. This deposit I first noticed as the broken cap-rock of the two buttes two miles southwest of Sheridan,

* On a chemical test, by Prof. Kedzie, some *iron* was found with the manganese.

† They were submitted to the inspection of the members at the reading of this article.

and half a mile from the line of the Kansas Pacific Railway. They form a notable landmark to travelers. It in like manner forms the cap-rock of all the high hills of that vicinity. It retains its thickness near Fort Wallace, but twenty-five miles south of Chalk creek had decreased one-half, and the best agates were only in the caps of two inches. The disintegration of the sand-rock would of itself give a poor soil. While this is its character in many places, in others we found a mixture of vegetation, which was fertile. Springs and streams are not abundant, but where found (like others in sandstone regions), the water is good; and we will add, that in all our experience of eight summers' camping in western Kansas, *we have never met with a single "alkali" spring, or a single acre white with alkali deposit.* There are a few, and but a few, salt springs which may at some day be made useful in furnishing settlers with salt.

We have thus given a few notes of this important geological formation, showing how little we yet know of our own territory.

## ON DETERMINING THE SOLUBILITIES OF METALLIC SALTS.

BY PROFS. GEO. E. PATRICK * AND ALFRED B. AUBERT.†

The determination of the solubility of a metallic salt in water or other solvent is apparently a matter so simple and so easy of execution as to offer little difficulty to the chemist; and hence one would naturally expect that the results of different chemists, who have investigated the solubility of the same salt, would show the greatest concordance. But notwithstanding this apparent simplicity, any one who has reviewed the subject must admit that the results obtained by different workers in this field show a lamentable lack of harmony. This lack of harmony must be due to the neglect of certain precautions essential to accurate work, which precautions must relate to one or all of the following points:

I. Purity of material.

II. Degree of saturation of the solvent at the temperatures at which the determinations are made.

III. Reliability of the process by which the amount of dissolved salt is estimated, and accuracy in the execution of that process.

Upon the first and third points the liability to error is comparatively slight, the exercise of ordinary care only being necessary. But upon the second point there is the greatest danger of error; for unless special precautions are taken, it is difficult to obtain a solution at any given temperature, containing the *normal amount* of salt for that temperature, *and no more;* for it is now quite well established that the ability to form *super-saturated* solutions, so strikingly exhibited by sodic sulphate, (Glauber's salt,) is likewise possessed in some degree by all salts—by most, it is true, in so slight a degree as to be, under ordinary circumstances and for ordinary purposes, quite inappreciable, but in such a degree, however, as to furnish ground for the belief that, unless carefully guarded against, it may, in the determination of solubilities, materially vitiate the results. Indeed, it seems probable that to the phenomenon of super-saturation are due most of the discrepancies so apparent between the different tables of solubilities. In support of this conclusion, we would refer to the manner in which the determinations of solubilities have, as a rule, been conducted.

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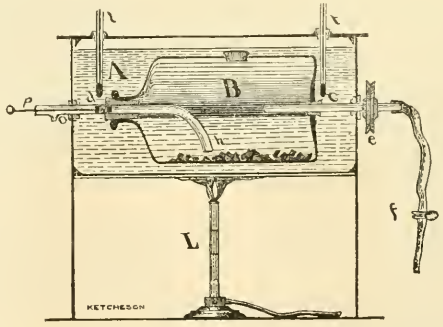
The plan usually adopted is, to make a saturated solution of the salt at the boiling point of the solvent (or of the saturated solution), and to allow it to cool gradually, with frequent or occasional agitation by the hand to prevent super-saturation, to the respective temperatures at which the determinations are made; at which temperatures portions of the liquid are withdrawn, and the amounts of dry salt contained therein, determined.

By such a method, where the temperature is being continually lowered, and there are no means of constant agitation, there is evidently a possibility, if not a probability, that super-saturation will occur. It was the object of the work herein described, to ascertain if it were not possible, by a simple mechanical contrivance and a different method of work, to avoid the errors arising from this cause; and to that end was employed the apparatus figured below. It consists of a copper tank *A* (shown here in section), inside of which revolves a bottle *B*, containing the salt to be dissolved and the solvent. This bottle is perforated at the base, and at the side. Through the perforation at the base, fitted tightly with a rubber stopper, passes a glass tube *c c*, having its outer end closed by a rubber tube and a pinch-clamp *f*. This tube serves as an axis of revolution, the power being applied by means of a cord passing over the grooved wheel *e e*, which is firmly attached to the tube *c c*, just outside the tank. The same tube also furnishes a means of producing pressure in the bottle sufficient to force out the solution through another tube *d d*, passing through a tight stopper in the neck of the bottle; which tube also serves as the axis of revolution. This tube is furnished with a tightly fitting piston *p;* and at a short distance outside the tank it has an orifice *o*, through which, when the piston is drawn out beyond that point, the solution is forced. Within the bottle this tube is bent so as to allow its end *h*, to be under the surface of the liquid in the bottle, even when but little remains.




The perforation *g* at the side, fitted tightly with a stopper, is for the purpose of introducing crystals of the salt as often as necessary, to keep the latter in excess of the solvent.

The lamp *L*, beneath the tank, serves to regulate the temperature, which is indicated by the two thermometers, *t t*.

For maintaining the bottle in revolution, any constant power may of course be used; but in the work already done with this apparatus, the motor employed has been a small electro-magnetic engine, excited by two Bunsen elements.

Our method of work is as follows: A large amount of the salt is introduced into the bottle (the amount depending of course upon the solubility of the salt under examination), the bottle nearly filled with distilled water, and put firmly in place. The tank is filled with water to a level above the top of the bottle, the latter set in revolution by the motor, and the lamp lighted. The temperature of the water in the tank, indicated by two *trusty* thermometers, is slowly raised to the *lowest* temperature at which a determination is to be made, and carefully kept at that point for one half-hour (or longer, if that is found insufficient for obtaining a saturated solution), special care being taken to avoid

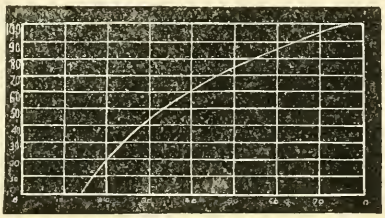
its getting at all—even a fraction of a degree—*above* the desired point, in order that super-saturation may be absolutely impossible.

At the end of one half-hour (or longer, if necessary) at that temperature, the machine is stopped and allowed to remain quiet ten or fifteen minutes, that the crystals may settle; the tube *d d* being turned at such an angle that the end *h* is in clear liquid, and not in the vicinity of crystals. A drawing is then made in the following manner: The piston *p* is drawn out until the opening *o* is cleared. One person blows into the bottle through the tube *c c* and its rubber attachment, at the same time pressing the clamp *f*, while another holds a tarred beaker provided with a ground-glass cover (the beaker itself having a ground edge) under the orifice *o* until the proper amount of solution is obtained. The ground-glass cover is quickly placed on the beaker, the whole is allowed to cool, and is then weighed. The amount of salt dissolved in that amount of solution is then determined by the most reliable and convenient method.

Parallel determinations were always made, the second drawing being made about one quarter-hour after the first, the bottle meantime having been kept in revolution, and the temperature constant. The determinations were made usually at intervals of 10° C., ranging from 0° or 10° to 90° or 100°.

In this way the solubilities of salts have been determined, both singly (one salt alone in water), and mixed (two salts, both present in excess of the solvent), with uniformly gratifying results, the curves being in each case more regular than any previously obtained; and all the results, with very few exceptions, show upon comparison with those on record, obtained by the old method of work, smaller amounts of salt dissolved at the respective temperatures—a fact which goes far to prove that super-saturation has, in some cases at least, been a vitiating element in the work.

We give below the curve for the solubility of anhydrous cupric sulphate ($Cu\,SO_4$) based upon the figures obtained by us, representing the number of parts of the anhydrous salt soluble in one hundred parts of water. We also give for comparison the figures actually obtained for the same salt, showing the magnitude of the discrepancies between parallel determinations.



We should state however, that in this curve the figures for 0° and 100° were obtained with the utmost care by our method of work (raising the temperature, not lowering it), but *not* with aid of the apparatus—flasks having been used instead. This work was performed at the laboratory of Cornell University, and we owe many thanks to Prof. C. H. Wing, non-resident Professor of Chemistry at Cornell, for his kind and valuable suggestions regarding it.

Parts $Cu\,SO_4$ (anhyd.) soluble in 100 parts water.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| At 0° C. | 13.98 | 14.31 | dif. .33 | At 60° C. | 39.00 | 39.02 | dif. .02 |
| At 10° C. | 17.34 | 17.65 | " .31 | At 70° C. | 45.61 | 45.87 | " .26 |
| At 20° C. | 20.58 | 20.49 | " .09 | At 80° C. | 54.63 | 54.33 | " .30 |
| At 30° C. | 24.37 | 24.32 | " .05 | At 90° C. | 63.50 | 64.14 | " .64 |
| At 40° C. | 28.50 | 28.50 | " .00 | At 100° C. | 75.18 | 75.26 | " .08 |
| At 50° C. | 33.34 | 33.32 | " .02 | | | | |

## RARE FORMS OF FISH IN KANSAS.

BY B. F. MUDGE.

About a year ago, there were sent to Hon. Alfred Gray, of Topeka, two fragments of fish jaw, without any statement of where they were found. The singular and unusual appearance of the teeth attracted my attention, and gave me not a little study to fix their relation to other fossils. Being at Osage City soon after, I procured two similar specimens, and learned that those of Topeka were from the same locality. The jaws were from a Cestraciont Selachian—entirely new to science. It is well known that the shark tribe, to which these belong, have no solid bones or any solid substance in the body, except the teeth; and consequently the latter are the only parts of the body ever fossilized, or which now remain to give us a knowledge of their structure and habits. As the jaws are cartilaginous, when the animal dies the ligaments holding the teeth together decay, and they become separate, and are not found in regular position. In the present case they are found in their natural and regular position. The jaws must have become imbedded in a firm clay, which retained the teeth together, after the cartillage decayed. The teeth being palatal, or pavement, covered the whole surface of the mouth, instead of being arranged in rows at the edge of the jaws, and we now have them in their natural arrangement. Many of the Cestracionts have no order in the position of their teeth; but in this specimen the rows are very regular, and must have numbered five hundred and sixty (560) in a single jaw. The largest teeth—two and a half inches in basal length—are found in the center of the mouth, and diminish in size as they approach the front; and the teeth also lessen in number toward the sides of the mouth. The best specimen contained over four hundred teeth in excellent order and preservation. A portion of one side of the jaw was gone, but the regular position of the remaining teeth was such that the number and situation of the missing one hundred and sixty (160) were easily calculated.

Knowing the value and importance of the specimen, I immediately wrote to Prof. O. St. John, who makes a specialty of the carboniferous fishes, in the museum of Cambridge, under Agassiz. He requested a specimen for study. He writes me that the jaw is remarkable, in showing teeth so unlike in different rows that paleontologists, when finding them separately, have described the teeth now in one as belonging to two genera and three species. He also adds that the lamented Agassiz stated on one occasion that if ever a perfect jaw of these ancient, extinct Cestracionts should be discovered, it would be found that several species now separated constitute but one. Thus ever true to nature was this great naturalist. He finds that these Cestraciont jaws throw much light on the earliest fossil fish, and the lowest type of fish of the present day. The affinities in this case are so different from what was previously known, that he has considered it a new genus and named it after Prof. Agassiz—Agazodus.

The most remarkable species of fish which we have found, the present season, are of a genus new to me, and I think to science. They are armed with a long, strong weapon at the extremity of the upper jaw, something like that of a sword fish, but round and pointed, and composed of strong fibres. The jaws are provided with three kinds of teeth. On the outer edge is a row of large, flat, cutting teeth, somewhat resembling those of a shark. Inside, and placed irregularly, are small, blunt teeth; while in the back portion of the palate is the third set—small, sharp and needle-like in shape, forming a pavement. The jaws are also fibrous, like the snout. There are three species of this genus. Prof. Marsh has them for critical scientific examination.

## REPORT ON BOTANY.

BY JAMES H. CARRUTH.

It would be very queer if, when we gave a man's name, we were obliged to give also the name of the person who gave him his name. But this is the way—I suppose properly—in Botany, and I have to acknowledge not having attended to this in my reports hitherto. Nor can I do it throughout in the present. If, at a future day, I am able to embody all the reports in one, I will try to do it.

I have not done much in the field the past year—partly from the pressure of other duties, but more because I have had my hands full of indoor work in this department, as will appear. Had I had more time, only the gleanings remained in Douglas county.

Last spring I sent to several persons copies of the reports already published, asking them to collect specimens of rare species, and also to make lists of such as they found, not already published.

The additions this year have come largely in this way. Prof. Snow, with the help of his students and correspondents, has furnished more than twenty. Miss M. P. Wright, of Burlington, has brought me specimens of three—two of them common at the East, but not hitherto found in Kansas. Miss E. C. Wright, living near Irving, Marshall county, has sent me a list of forty or fifty, of which she feels certain, but her specimens have been accidentally spoiled. Mr. E. A. Popenoe, of Topeka, has made a trip to Western Kansas, and has given me a list of more than forty found there and at home. Dr. L. Watmer, of Ellis, has sent me plants all summer—more than I have found time to analyze. Indeed, the plants of Western Kansas are so different from those east of the Mississippi—the field of Wood and Gray—that I could not have done much with them, had not Dr. W. kindly put me in the way to get Porter & Coulter's Flora of Colorado; and even with this aid, the work has been slow, because dried specimens, especially of small plants, are much more difficult to analyze than fresh ones. Stamens and pistils often afford no aid, and the form of the flower is often spoiled. Still I think I have succeeded with most that I have tried, and am very sorry that I could not have tried all. If I or those who have reported to me have made mistakes, we will try to have all right in the final summing up.

Our previous lists have made over 800. The lists given me this year are in part the same, but make in all about 140 different ones. Porter & Coulter give, as the result of the observations of some six to ten botanists in Colorado, about 1,050 species, including the lilies and one or two other small orders of cryptogamin. Mr. N. Colman has published a Flora of Southern Michigan, and his catalogue contains 1,375 copies, including as above.

Prof. Wood's Class Book describes about 3,900 species growing east of the Mississippi, a large proportion being found in the South Atlantic and Gulf States.

In view of these facts, I think we may expect to find in Kansas about 1,200 species. I have mentioned Porter & Coulter. I would recommend to Kansas botanists, specially at the west, to procure their work. It may be had by writing to the Department of the Interior, and sending a dime or two to pay postage. The species not in Gray's Manual are described fully. Generic descriptions, outside of Gray, are also given. The genera not in Gray are 94, and the species over 600.

The tendency is quite strong of late to consider some forms of plants which have been hitherto regarded as species as only varieties. I think it will require long and close observation to determine some questions of this kind. Animals in their wild state, are but little inclined to run into varieties. Domestic animals, much. It seems to be so with plants. If wild species vary, why should we not expect to find "grades" indefinitely, as among uncultivated ones? To me it seems that however close the resemblance between

two forms, if they do not graduate into each other, but remain distinct in the neighborhood of each other, they should be regarded as species. Botanically the most obvious difference between the apple and the pear, is in the fruit. Apples are globular, oblate, prolate and conical, but never *ob*-conical, the form of the pear. Even an intermediate form might be a hybrid, and would not prove the other two to be only varieties. Among animals, hybrids rarely occur without the agency of man. Why should we not expect that, where fertilization depends on the wind or the position of the stamens and pistils, hybridization should be extremely rare? But when it depends on insects or Mr. Rogers, it should be more common.

An interesting article on hybridization and crossbreeding may be found in the Report of the Department of Agriculture for 1867.

Bearing on the same subject is a little experiment of mine. In 1870, I planted seed of a small winter squash,—name not known—oblong, fluted, dark green or orange, or partly both, about five inches long, and three or four in diameter. One or two of the resulting plants bore squashes of the same form, but twice as large, and of the color of the scalloped flat summer squash. I regarded them as hybrids, and wanted to see if the seeds would vegetate. The next year I planted them, and they came up well and bore, but every squash was like the oblong parent.

I have several times tried to raise pawpaws, planting the seed in the fall without drying, both in and out of the fruit, but without success. Last spring, I tried the plan recommended for the Osage orange. I took seed that had been buried during the winter, soaked them two or three weeks, changing the water, planted them in a shady place, and watered them often. They waited so long that I despaired of them, but in June or July they appeared.

I have raised mulberries from seed by washing the seeds soon after it was ripe, planting it in a shady place in earth not clayey, and watering it every evening. It came up in about ten days.

I have this year found the artichoke, Helianthus tuberoses, growing spontaneously in my garden. Last year I tried to analyze it, but failed because the Helianthus tuberoses being called an exotic, in both Wood and Gray, I passed it by.

H. lentriularis, said by Mr. Hall to grow in Kansas, I have not recognized till this year, because I had no description of it. I now find it abundant. It is one of the few that have a brown disk.

Hitherto, so far as I know, no representative of the large order Ericaceæ has been found in Kansas. This year one, the Monotropa uniflora, or ghost flower, has been found at Vinland, by Miss Sarah Cutter.

Plants not in Gray's Manual nor Wood's Class Book, are marked thus*.

## CATALOGUE OF PLANTS.

RANUNCULACEÆ.

*Clematis*, Virgin's Bower.

* C. Fremontii. Ellis: Watson.

*Aquilegia*, Columbine.

* A. brevistylis? Fruit and flowers not seen. Lawrence: Snow.

*Ranunculus*, Crowfoot.

R. aquatilis L. Ellis: Watson.

NYMPHÆACEÆ.

*Nuphar*, Yellow Pond Lily.

N. advena, ait. Burlington: Miss M. P. Wright.

PAPAVERACEÆ.

*Sanguinaria*, Blood-root.

S. Canadensis L. Ft. Leavenworth: Lieut. Wilcox.

CRUCIFERÆ.

*Arabis*, Rock Cress.

A. Thaliana L. Between Lawrence and Topeka. Also Ellis: Watson.

*Erysimum*, False Wall Flower.

E. cheiranthoides L. Irving: Miss E. C. Wright.

*Camelina*, Crantz, False Flax.

C. sativa Crantz. Fruit and flowers not seen. Lawrence: Snow. Also Topeka: Popenoe.

VIOLACEÆ.

*Viola*, Violet.

* V. Nuttullii Ph. Ellis: Popenoe.

CARYOPHYLLACEÆ.

*Paronychia*, Nailwort.

P. dichotoma Nutt. Ellis: Watson.

MALVACEÆ.

*Sida.*

S. alæoides Mx. (Callirhoe Gray.) Burlington: Miss M. P. W.

LINACEÆ.

*Linum*, Flax.

L. rigidum Ph. W. Kansas: Popenoe. Also Ellis: Watson.

ZYGOPHYLLACEÆ.

Kallstrœmia maxima, Tribulus L. Dodge: Popenoe.

LEGUMINOSÆ.

*Cassia*, Senna.

C. nictitans L. Ft. Leavenworth: Lieut. Wilcox.

*Lespedeza*, Bush Clover.

*L. angustifolia. Ellis: Watson.

*Psoralea.*

*P. digitalis Nutt. Atchison: Popenoe.

*P. lanceolata Ph. Ellis: Watson.

*P. cuspidata Ph. Ellis: Watson.

*Dalea.*

*D. laxiflora Ph. W. Kansas: Popenoe. Also Ellis: Watson.

*D. aurea. Salina: J. Henry.

*Hosackia.*

*H. Purshiana. Salina: J. Henry.

*Petalostemon.*

P. carneum Mx. Irving: Miss E. C. Wright.

*Astragulus.*

*A. Shortii Nutt, Ext. W. Kansas: Popenoe.

*A. bisulcatus, Gr. Ext. W. Kansas: Popenoe, and Ellis: Watson.

*A. Parryi Gr. Ellis: Watson.

*A. leptaleus Gr. Ellis: Watson.

*A. racemosus Ph. Ellis: Watson.

*A. Missouriensis Nutt. Ellis: Watson.

*Wistaria.*

W. frutescens D. C. Irving: Miss E. C. W.

*Chaseolus*, Bean.

P. helvolus L. Irving: Miss E. C. W.

ROSACEÆ.

*Prunus*, Plum Cherry.

P. Virginiana D. C. Irving: Miss E. C. W.

P. pumila Mx. Ellis: Watson.

*Amelanchier*, June Berry.

A. Canadensis T. and G. Atchison county: Miss E. C. W.

*Crataegus*, Thorn.

C. tomentosa L. Lawrence: Snow.

*Rosa*, Rose.

*R. Arkansana Porter. Ellis: Watson.

ONAGRACEÆ.

*Œnothera*, Evening Primrose.

*E. plumatifida Nutt. W. Kansas: Popenoe.

*E. Hartroegii. Ellis: Watson.

*E. pumila. Ellis: Watson.

*E. Canescens. Ellis: Watson.

*Gaura.*

*G. parviflora.

CACTACEÆ.

*Mammilaria.*

M. Nuttallii, Eng. Var. W. Kansas: Prof. Mudge.

UMBELLIFERÆ.

*Chærophyllum.*

C. procumbens Lam. Lawrence and Topeka: Popenoe.

CORNACEÆ.

*Cornus*, Dogwood.

C. stolonifera Mx. Irving: Miss E. C. W.

RUBIACEÆ.

*Galium*, Bedstraw.

G. cirœzans Mx. Salina: J. Henry.

*Houstonia*, Bluets.

H. angustifolia Mx. Irving: Miss E. C. W. Also Ellis: Watson.

COMPOSITÆ.

*Liatris.*

*L. ————. Ellis: Watson.

*Eupatorium*, Boneset.

E. parviflorum Ell. Irving: Miss E. C. W.

*Solidago*, Golden Rod.

*S. pumila T. & G. Ellis: Watson.

S. lanceolata Art. Irving: Miss E. C. W.

S. gigantea Art. Irving: Miss E. C. W.

*Rudbeckia*, Cone flower.

R. lacinlata L. Irving: Miss E. C. Wright.

*Helianthus*, Sun Flower.

H. annuus L. Irving: Miss E. C. W.

H. tuberosus L. Lawrence. Also Irving: Miss E. C. W.

*Actinomeris.*

A. helianthoides Nutt. Irving: Miss E. C. W.

*Gaillardia.*

G. ——. Dodge: Popenoe.

*Hymenopappus.*

H. tennifolius Phx. Salina: J. Henry.

*Hellenium.*

H. tanacetifolium. Western Kansas: Popenoe.

*Artimesia*, Wormwood.

A. frigida Willd. Irving: Miss E. C. W.

A. biennis Willd. Irving: Miss E. C. W.

*Senecio*, Groundsel.

*S. longiloba. Ellis: Watson.

*Cirsium*, Thistle.

*C. undulatum. Western Kansas: Popenoe. Also Salina: J. Henry.

*Lygodesmia.*

*L. Juncea. Western Kansas: Popenoe.

*Mulgedium*, Wild Lettuce.

M. Floridanum X. Lawrence. Also Ellis: Watson

ERICACEÆ.

*Monotropa*, Indian Pipe.

M. uniflora Retz. Ellis: Watson.

PRIMULACEÆ.

*Androsace.*

A. filiformis. Ellis: Watson.

PLANTAGINACEÆ.

*Plantago*, Plantain.

P. Punilla Nutt. Salina: J. Henry.

P. aristata (a dwarf var.) Ellis: Watson.

OROBANCHACEÆ.

*Aphyllon.*

A. fusinulatum S. & G. Irving: Miss E. C. W.

SCROPHULARIACEÆ.

*Pentstemon*, Beard Tongue.

P. grazillis Nutt. Lawrence.

*Mimulus*, Monkey flower.

M. Jamesii Torr. Irving: Miss E. C. W.

*Veronica*, Speedwell.

V. Americana Schw. Irving: Miss E. C. W.

*Gerardia.*

G. purpurea L. Irving: Miss E. C. W.

*Castilleja.*

C. sessiflora Ph. Salina: J. Henry. Also Ellis: Watson.

VERBENACEÆ.

*Vebena*, Vervain.

* V. Vipinnatifida. Ellis: Watson.

*Lippia.*

L. cunefolia. Dodge: Popenoe.

L. lanceolata. Ellis: Watson.

LIBIALÆ.

*Lycopus.*

L. Virginicus L. Irving: Miss E. C. W.

*Salvia*, Page.

S. Angustifolia. Lawrence: Snow.

*Scutellaria*, Skull-cap.

S. lateriflora L. Lawrence: Snow.

* S. racemosa Torr. Ellis: Watson.

BORRAGINACEÆ.

*Eclinospermum.*

E. Lappula. Irving: Miss E. C. W. Also Lawrence: Snow.

POLEMONIACEÆ.

*Phlox.*

P. Carolina. Irving: Miss E. C. W.

CONVOLVULACEÆ.

*Ipomea.*

I. leptophylla Torr. Hutchinson: Popenoe.

*Calystegia.*

C. Calesbiana Ph. Irving: Miss E. C. W.

*Cuscuta*, Dodder.

C. arvensis var. Irving: Miss E C. W.

ASCLEPIADACEÆ.

*Asclepias*, Milkweed.

* A. speciosa. Hutchinson: Popenoe.

* A. Jamesii Torr. Ext. W. Kansas: Popenoe.

A. verticillata (a dwarf variety.) Ellis: Watson.

*Enslenia.*

E. Albida Nutt. Irving: Miss E. C. W.

POLYGONACEÆ.

*Rumex*, Dock.

R. verticillatus L. Irving: Miss E. C. W.

CHENOPODIACEÆ.

*Chenopodium*, Goosefoot.

C. Glaucum. Irving: Miss E. C. W.

C. Boscianum. Irving: Miss E. C. W.

AMARANTACEÆ.

*Amarantus.*

A. blitum L. Lawrence. A common weed described in Eaton, and in the old edition of Wood, but omitted in later editions, and in Gray.

EUPHORBIACEÆ.

*Euphorbia*, Spurge.

S. obtusata Ph. Irving: Miss E. C. W.

*Croton.*

C. ——— undetermined. Ellis: Watson.

CALLITRICTIACEÆ.

*Callitriche.*

C. verna L. Ellis: Watson.

C. autumnalis L. Irving: Miss E. C. W.

PODOSTEMIACEÆ.

*Podostemum.*

P. cerotophyllum Mx. Lawrence.

CERATOPHYLLACEÆ.

*Cerotophyllum.*

C. dermersum L. Ellis: Watson.

CUPULIFERÆ.

*Ostrya*, Iron Wood.

O. Virginica Willd. Fort Leavenworth: F. Van Vliet.

ARACEÆ.

*Pistia.*

P. Stratiotes L. Ellis: Watson.

*Arisæma.*

A. quinatum. Irving: Miss E. C. W.

LILIACEÆ.

*Yucca.*

F. angustifolia Ph. W. Kansas: Popenoe.

F. filamentosa. Salina: J. Henry.

PONTEDERIACEÆ.

*Pontedria*, Pickerel Weed.

P. cordata Burlington: Miss M. P. Wright.

JUNCACEÆ.

*Juncus.*

J. repeus Mx. Ellis: Watson.

CYPERACEÆ.

*Cyperus*, Ledge.

C. Erythrorhizos Mohl. Lawrence: Snow.

C. dentatus Torr. Lawrence: Snow.

C. Schweinitzii. Lawrence: Snow.

*Carex.*

C. Muhlenbergii. Lawrence: Snow.

C. Schweinitzii. Irving: Miss E. C. W.

C. Pennsylvanica Lam. Irving: Miss E. C. W.

C. argyrantha Tuckm. Irving: Miss E. C. W.

C. sparganoides Muhl. Irving: Miss E. C. W.

C. setacea Dew. Irving: Miss E. C. W.

C. oxylepis Torr. Irving: Miss E. C. W.

C. blanda Dew. Irving: Miss E. C. W.

C. gracillima Schw. Irving: Miss E. C. W.

C. conoidea Sch. Topkea: Popenoe.

* C. alveoluteus. Topeka: Popenoe.

GRAMINEÆ.

*Alopecurus.*

A. aristulatus Mx. Salina: J. Henry.

*Paspalum.*

P. sanguinale Lam. Lawrence.

*Tricuspis.*

T. acummata. Dodge: Popenoe.

*Festuca*, Fescue Grass

F. tenella Willd. Topeka: Popenoe.

F. nutans Willd. Topeka: Popenoe.

*Poa.*

P. trivialis. Leavenworth: Wherrell.

*Bryzopyrum.*

B. spicatum Hook. W. Kansas: Popenoe.

*Hordeum*, Barley.

H. Jubatum L. Irving: Miss E. C. W.

*Elymus*, Wild Rye.

E. striatus Willd. Lawrence.

*Triticum*, Wheat.

T. repens var. W. Kansas: Popenoe.

*Boutelowa.*

B. hirsuta Lag. Dodge: Popenoe.

*Erianthus.*

E. brevibarbis Mx. Irving: Miss E. C. W.

Species, about 140; not in class book, 45.

Several species of grasses are not enumerated in this catalogue, for want of time to determine them

LAWRENCE, December, 1874.

## OBSERVATIONS ON THE USE OF THE ANTENNÆ OF POLYPHILLA VARIOLOSA.—HARRIS.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

Penikese Island, the site of the Anderson School of Natural History, is one of the group known as the Elizabeth Islands, situated about half way between Martha's Vineyard and the city of New Bedford, some sixteen miles from each of these localities. This almost barren island contains about eighty acres of land, and is entirely destitute of shrubs and trees, thus affording a very unpromising collecting-ground for an entomologist.

While walking over the eastern elevation of the island, after sundown, on July 13, the writer obtained two or three specimens of an insect belonging to the Scarabæan family of Coleoptera, described by Harris as *Melolontha Variolosa*, but now referred to the genus *Polyphylla*. Harris speaks of this beetle as "occurring abundantly in the month of July at Martha's Vineyard, and in some other places near the coast;" but as "rare in other parts of Massachusetts." In general appearance, mode of development, and habits, it resembles the common May beetle, *Phyllophaga fusca*, Frohl. The larva and pupa stages of its existence are spent in the ground. The imago is reddish brown, marked above with obscure whitish stripes on account of which Harris styled it "the scarred Melolontha." Like the May beetle, it flies abundantly at dusk and during the evening. It differs from the various species of *Phyllophaga*, however, in the remarkable structure of its antennæ, the "club" of which is composed of seven broad ligulate plates or leaves. These antennal plates have a much greater development in the male than in the female, so that the sexes may be readily distinguished at a considerable distance.

It is one of the most curious discoveries of recent investigators into the physics of entomology, that an exceedingly delicate auditory apparatus exists in the antennæ of many insects. At the meeting of the National Academy of Sciences in November, 1873, Professor A. M. Mayer described a series of experiments upon the antennæ of the male mosquito. Placing one of these insects alive upon the stage of his microscope, he observed the effects produced upon the numerous sensitive fibrillæ with which the joints of the antennæ are provided. By bringing a vibrating tuning-fork into close proximity to the mosquito, he observed that certain of the fibrillæ were thrown into rapid motion, while the rest were comparatively motionless. Substituting a second tuning-fork, sounding a different note, the first series of fibrillæ remained motionless, while a second series was thrown into rapid vibration. The experiment was continued with tuning-forks of still other tones, with similar results. Professor Mayer thus made the discovery that the fibrillæ of the mosquito's antennæ are tuned by nature to vibrate in sets in unison with sounds of different quality.

In the antennal plates of *Polyphylla variolosa* no fibrillæ are present, but the surfaces of these plates are furnished with innumerable minute vesicles, each of which is provided with a nerve to communicate the vibrations received by the vesicle from the sounding body.

The use of the antennæ of the male mosquito is undoubtedly to guide him to his mate, whom he must find in the dark. Professor Mayer has shown that the song of the female mosquito has the power of vibrating the fibrils of the antennæ of the male in such a way as to enable him to direct his flight in a straight line to the object of his search. In the case of *Polyphylla variolosa* I believe that the male antennæ have a similar function, and that these organs in the genus have a development so far surpassing other genera of the group to which it belongs, on account of the peculiarly difficult circumstances under which the male discovers the whereabouts of the female.

Two days after securing my first specimens of this beetle, at dusk July 15, 1874, I visited the same spot and found these insects so abundant that upwards of fifty specimens

were obtained in a quarter of an hour. On this occasion, though pleased to obtain so much material for cabinet and laboratory uses, I was especially gratified in observing the actions of the males in searching for their mates. My attention was first arrested by a male vigorously scratching the ground with his feet while his antennæ were fully extended with their antennal plates widely separated. His progress being too slow to suit my purpose, I assisted him in his excavation, and at a depth of half an inch discovered a female who, with head upwards, was struggling to reach the surface, having evidently but just emerged from the pupa. A little further on another male was busily scratching the soil, and another female was unearthed directly underneath, while a moment later two rival males were discovered digging for a third female who was buried nearly an inch below the surface.

Two or three evenings later I visited the same spot, but found the pairing season evidently over, only two or three single specimens rewarding my search. But the repeated observations of July 15, have convinced me that the male antennæ of *Polyphylla variolosa* have an excessive development in size, and an extreme sensibility to sound vibrations in order to enable them to ascertain the position of their mates while yet buried in the ground.

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## METEOROLOGICAL SUMMARY FOR THE YEAR 1874.

PROF. F. H. SNOW'S ANNUAL REPORT AS METEOROLOGIST, TO THE STATE BOARD OF AGRICULTURE.

Station, Lawrence, Kansas; Latitude 38° 58'; Longitude 95° 16'; elevation of barometer and thermometers, 884 feet above the sea level, and 14 feet above the ground; rain gauge on the ground; anemometer 105 feet above the ground, on the dome of the University building.

### TEMPERATURE.

Mean temperature of the year, 54°.2, which is 1°.25 above the mean of the six preceding years. The highest temperature was 108°, on the 5th of August; this being 4° higher than any previous observation on our seven years' record. The lowest temperature was 3° below zero, on the 29th of December; this being 2° higher than any previous annual minimum on our record. Mean temperature at 7 A. M., 47°.88; at 2 P. M., 62°.49; at 9 P. M., 50°.18.

Mean temperature of the winter months, 28°.88—00.08 above the average; of the summer, 80°.92—4°.53 above the average; of the autumn, 53°.92—1°.62 above the average.

The coldest month of the year was February—the coldest February on our record—with mean temperature 27°.5; the coldest week was February 20th–26th, with mean temperature 19°.24; the coldest day was December 29, with mean temperature 7°.3. The mercury fell below zero but twice—January 3, and December 29.

The hottest month of the year was July, with mean temperature 83°.62; the hottest week was July 19th–25th, mean temperature 89°.33; the hottest days were August 5 and 11, which each had a mean temperature of 94°. The mercury reached or exceeded 90° on 58 days, viz: 4 in May, 6 in June, 21 in July, 24 in August, and 3 in September. There were 9 days on which the mercury reached or exceeded 100°, viz: July 24, 25, and August 5, 9, 10, 11, 12, 13 and 17.

The last light frost of spring was on April 23; the first light frost of autumn was on September 15, giving a period of 145 days entirely without frost. The last severe frost of spring was on April 9; the first severe frost of autumn was on October 23, giving a period of 207 days without severe frost. No cold weather during the year caused any damage to fruit.

RAIN.

The entire amount of rain, including melted snow, was 28.87 inches, which is the smallest annual rainfall on our seven years' record, and falls below the average rainfall of the past six years by 5.48 inches. Either rain or snow fell on 99 days, 4 less than the average number. The longest interval without rain during the growing season, March 1 to October 1, was 15 days, from July 23 to August 9. The number of thunder showers was 20. The marked deficiency in the rainfall of July and August resulted in great damage to the crops in all parts of Kansas, and produced the only severe and extended drouth since 1860. The amount of excess or deficiency in the rainfall of each month of the year is indicated in the table appended to this report.

SNOW.

The entire depth of snow was 43 inches, distributed as follows: January, 7½ inches; February, 10 inches; March, 4 inches; November, 14 inches; December 7½ inches. The last snow of spring was on April 16; the first autumn snow was on November 17. The annual amount of snow, as given above, is 20.58 inches above (nearly double) the average for the six preceding years.

FACE OF THE SKY.

Average cloudiness of the year 45.54 per cent. of the sky, which is only 0.06 per cent. below the average. The number of clear days (less than one-third cloudy) was 155; half clear days (between one-third and two thirds cloudy) 108; cloudy (more than two-thirds) 102. There were 27 days without a cloud, and 30 days without a trace of sky. August was the clearest month, with a mean cloudiness of 24.95 per cent. March was the cloudiest month, mean cloudiness, 62.27 per cent. The mean cloudiness at 7 A. M. was 50.79 per cent.; at 2 P. M. 48.82 per cent.; at 9 P. M. 37 per cent.

DIRECTION OF THE WIND.

During the year (three observations daily) the wind was from the southwest, 335 times; northwest, 224 times; northeast, 190 times; southeast, 142 times; south, 76 times; north, 54 times; east, 42 times; west, 8 times; calm, 24 times. The south (including southeast, south and southwest) winds outnumbered the north (including northeast, north and northwest) winds in the ratio of 553 to 468.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 145,865. This gives a mean daily velocity of 399.6 miles, and a mean hourly velocity of 16.62 miles. The position of the anemometer cups at an elevation of 105 feet above the ground, the most elevated point for many miles in all directions, secures exposure to the full force of the wind. The maximum velocity attained was 65 miles an hour on September 18. The greatest daily velocity was 1,061 miles on January 3. The strongest winds were in April and November; the lightest were in February and June.

BAROMETER.

Mean height of the barometer column, 29.121 inches. Mean at 7 A. M., 29.146 inches; at 2 P. M., 29.096 inches; at 9 P. M., 29.121 inches; maximum, 29.845 inches, at 7 A. M., January 24; minimum, 28.267 inches, at 2 P. M., November 22, this being the lowest reading on our record except that of January 16, 1870, 28.191 inches; yearly range, 1.578 inches. The highest monthly mean was in December, 29.235 inches; the lowest was in May, 29.027 inches. The barometer observations are corrected for temperature, but not for elevation, thus affording the means of determining the altitude of our station.

RELATIVE HUMIDITY

Mean for the year, 65.52; at 7 A. M., 76.5; at 2 P. M., 49.18; at 9 P. M., 70.87. The dampest month was December, humidity 79.4; the driest month was August, humidity 49.02. There were 14 fogs during the years.

FORCE OF VAPOR (IN INCHES).

Mean for the year, 0.319; at 7 A. M., 0.317; at 2 P. M., 0.310; at 9 P. M., 0.329; greatest, 0.863 at 9 P. M. July 30; least, 0.038 at 7 A. M. December 29; highest monthly mean, in June, 0.603; lowest, in January, 0.121.

The following table gives the mean temperature, the extremes of temperature, the relative humidity, and the rainfall for each month of the year 1874; also a comparison with preceding years:

| Month. | Mean temperature | Maximum temperature | Minimum temperature | Relative humidity. | Rainfall in inches | Excess or deficiency of rainfall. |
|---|---|---|---|---|---|---|
| January | 28.01 | 61.0 | —2.5 | 73.07 | 2.35 | *1.04 |
| February | 27.50 | 49.0 | 2.0 | 78.21 | 0.95 | †0.01 |
| March | 39.50 | 69.5 | 19.0 | 67.12 | 2.30 | *0.23 |
| April | 48.07 | 83.0 | 22.5 | 57.73 | 2.86 | †0.14 |
| May | 69.76 | 95.0 | 45.0 | 55.60 | 1.41 | †2.68 |
| June | 77.11 | 95.0 | 53.5 | 66.02 | 3.58 | †0.01 |
| July | 83.62 | 103.0 | 68.0 | 52.15 | 1.19 | †3.96 |
| August | 83.45 | 108.0 | 65.0 | 49.02 | 1.00 | †3.97 |
| September | 67.03 | 94.0 | 41.0 | 71.70 | 6.45 | *3.23 |
| October | 56.01 | 89.0 | 19.5 | 67.20 | 1.92 | †0.69 |
| November | 38.76 | 77.5 | 5.5 | 72.47 | 3.69 | *2.08 |
| December | 31.01 | 55.5 | —3.0 | 79.40 | 1.17 | †0.58 |

*Excess. † Deficiency.

COMPARISON WITH PRECEDING YEARS.

| Year. | Mean temperature | Maximum temperature | Minimum temperature | Relative humidity. | Rainfall in inches |
|---|---|---|---|---|---|
| 1874 | 54.20 | 108.0 | —3.0 | 65.52 | 28.81 |
| 1873 | 52.71 | 104.0 | —26.0 | 64.06 | 32.94 |
| 1872 | 51.90 | 97.0 | —18.0 | 64.40 | 32.63 |
| 1871 | 54.30 | 103.0 | —6.0 | ..... | 33.23 |
| 1870 | 54.50 | 102.0 | —10.0 | 68.40 | 31.38 |
| 1869 | 50.99 | 96.0 | —5.0 | ..... | 38.51 |
| 1868 | 53.36 | 101.0 | —16.5 | ..... | 37.42 |

## BIRDS OF KANSAS.

BY PROF. FRANK H. SNOW, OF THE STATE UNIVERSITY.

Since the publication of my catalogue of the birds of Kansas in the transactions of the Kansas Academy of Science for 1872, the following additional species have been observed, viz:

1. *Colaptes Mexicanus*—Red-Shafted Flicker. A large flock of this species remained for about two weeks in the timber along the Kansas river within a mile of Lawrence, in December, 1872. A specimen was obtained for the University cabinet by Nelson J. Stephens. A single specimen was also seen and identified by the writer in the same locality, March 26, 1874. The occurrence of this species here is worthy of notice, from the fact that the Hybrid Woodpecker (*C. hybridus*) had previously been taken in several instances in this vicinity, the latter form being generally supposed to be a cross between the common Yellow-Shafted Flicker (*C. auratus*) and this newly discovered Red-Shafted Flicker. An interesting fact in this connection was the capture (April 12, 1871, by Eugene Kennedy, a Universitiy student) of a pair of Woodpeckers, with a nest of eggs containing young birds, the male parent being an albino specimen of *C. hybridus* and the female a specimen in ordinary plumage, of *C. auratus*.

2. *Helmitherus vermivorus*—Worm-eating Warbler. A single specimen was taken at Lawrence May 6, 1873, by Miss Lizzie Yeagley, the bird having flown into the house through an open window.

3. *Dendroeca striata*—Black Poll Warbler. Several specimens were found dead (May 21, 1873, by Geo. F. Gaumer), having in migration dashed against the walls of the old University building during the severe storm of the preceding night.

4. *Dendroeca maculosa*—Black and Yellow Warbler. One specimen, contributed by W. J. McLaughlin, of Centralia.

5. *Ampelis garrulus*—Northern Waxwing. A single specimen, taken at Fort Riley, by Dr. Hammond, is in the collection of the Smithsonian Institution at Washington. This bird, a native of British America, is never found so far south as Kansas, except in extremely cold weather.

6. *Micropalama himantopus*—Stilt Sandpiper. Several specimens were taken near Lawrence, September 9 and 19, 1874, by W. Osburn. This species was taken in Montana last summer by Dr. Coues.

7. *Calidris arenaria*—Sanderling. A single specimen was taken at Lawrence by W. E. Stevens, October 7, 1874. Dr. Coues writes that this species has never before been known in the interior, except along the great lakes.

8. *Larus Delawarensis*—Ring-billed Gull. Taken at Lawrence, April 2, 1873, by N. J. Stephens; a second specimen was taken at Leavenworth the same week by Prof. John Wherrell.

9. *Podiceps auritus, var. Californicus*—The Eared Grebe. Taken near Lawrence, April 24 and 26, 1873, by Joseph H. Weeks and N. J. Stephens; also April 18, 1874, by C. H. Harris. This species is abundant on the Pacific coast, but has never before been taken so far east of the Rocky Mountains. Dr. Coues, in the American Naturalist, notes the occurrence of this bird in Montana Territory on a meridian about 300 miles west of Lawrence.

With the preceding additions, the list of Kansas birds now contains 290 species. Sportsmen and naturalists are solicited to co-operate with the writer in making this catalogue even more complete. Rare specimens should be sent to him for preservation.

LAWRENCE, January 13, 1875.

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